APPENDIX D

AIR QUALITY

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACAM	Air Conformity Applicability Model
AESO	(Navy) Aircraft Environmental Support Office
AGE	auxiliary ground equipment
AGL	above ground level
APU	auxiliary power unit
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
CT/COB	continuation training/cost of business
CTOL	conventional take-off and landing
CV	carrier variant
CY	calendar year
EAC	early action compact
ETR	engine thrust ratio
FDEP	Florida Department of Environmental Protection
FFR	fuel flow rate
GBU	guided bomb unit
GHG	greenhouse gas
GOV	government-owned vehicle
HAP	hazardous air pollutant
IJTS	Integrated Joint Training Site
JSF	Joint Strike Fighter
lb	pound
LTO	landing and take-off
$\mu g/m^3$	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
MJU	munitions countermeasures unit
mm	millimeter
N_2O	nitrous oxide
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NEW	net explosive weight
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
ppm	parts per million
ROD	Record of Decision
ROI	region of influence
SEIS	Supplemental Environmental Impact Statement
SO_2	sulfur dioxide
STOVL	short take-off vertical landing
TGO	touch and go
TP	target practice
U.S.	United States
USEPA	U.S. Environmental Protection Agency
VMT	volume of miles traveled
VOC	volatile organic compound
yr	year

AIR QUALITY

This appendix presents an overview of the Clean Air Act (CAA) and the state of Florida air quality program. The appendix also discusses emissions factor development and calculations, including the assumptions used for the air quality analyses presented in the Air Quality sections.

AIR QUALITY PROGRAM OVERVIEW

In order to protect public health and welfare, the U.S. Environmental Protection Agency (USEPA) has developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for six "criteria" pollutants (based on health-related criteria) under the provisions of the CAA Amendments of 1970. There are two kinds of NAAQS: primary and secondary standards. Primary standards prescribe the maximum permissible concentration in the ambient air to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards prescribe the maximum concentration or level of air quality required to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (40 Code of Federal Regulations [CFR] 50).

The CAA gives states the authority to establish air quality rules and regulations. These rules and regulations must be equivalent to, or more stringent than, the federal program. The Division of Air Resource Management within the Florida Department of Environmental Protection (FDEP) administers the state's air pollution control program under the authority of the Florida Air and Water Pollution Control Act and the Environmental Protection Act.

As of February 2, 2012, Florida has repealed the state ambient air quality standards and adopted the NAAQS. Federal ambient air quality standards are presented in Table D-1.

Based on measured ambient air pollutant concentrations, the USEPA designates areas of the United States as having air quality better than (attainment) the NAAQS, worse than (nonattainment) the NAAQS, and unclassifiable. The areas that cannot be classified (on the basis of available information) as meeting or not meeting the NAAQS for a particular pollutant are "unclassifiable" and are treated as attainment until proven otherwise. Attainment areas can be further classified as "maintenance" areas, which are areas previously classified as nonattainment but where air pollutant concentrations have been successfully reduced to below the standard. Maintenance areas are under special maintenance plans and must operate under some of the nonattainment area plans to ensure compliance with the NAAQS. All areas of the state are in compliance with the NAAQS. Therefore, every county within the project region of influence (ROI) is classified as being in attainment.

Table D-1. Summary of National Ambient Air Quality Standards

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 μg/m3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution [71 FR 61144, Oct 17, 2006]	$PM_{2.5}$	primary and secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
			24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[38 FR 25678, Sept 14, 1973]		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Sources: USEPA, 2012 (Federal Standards); FDEP, 2012 (Florida Standards)

ppm = parts per million; ppb = parts per billion mg/m^3 = milligrams per cubic meter; μg/m^3 = micrograms per cubic meter

1. Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
2. The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
3. Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
4. Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Florida has a statewide air quality monitoring network that is operated by both state and local environmental programs (FDEP, 2003). The air quality is monitored for carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. The monitors tend to be concentrated in areas with the largest population densities. Not all pollutants are monitored in all areas. The air quality monitoring network is used to identify areas where the ambient air quality standards are being violated and plans are needed to reduce pollutant concentration levels to be in attainment with the standards. Also included are areas where the ambient standards are being met, but plans are necessary to ensure maintenance of acceptable levels of air quality in the face of anticipated population or industrial growth.

The end result of this attainment/maintenance analysis is the development of local and statewide strategies for controlling emissions of criteria air pollutants from stationary and mobile sources. The first step in this process is the annual compilation of the ambient air monitoring results, and the second step is the analysis of the monitoring data for general air quality, exceedances of air quality standards, and pollutant trends.

The FDEP Northwest District operates monitors in several counties, including Bay, Escambia, Holmes, Leon, Santa Rosa, and Wakulla Counties. Over the years of record, there have been exceedances (pollutant concentration greater than the numerical standard) of an NAAQS. However, there has not been a violation (occurrence of more exceedances of the standard than is allowed within a specified time period) of an ambient standard (FDEP, 2003).

Project Calculations

Methodology

Impacts to regional air quality are determined by comparing the project emissions with the total emissions on a pollutant-by-pollutant basis for the ROI's 2008 National Emissions Inventory (NEI) data. Potential impacts to air quality are evaluated with respect to the extent, context, and intensity of the impact in relation to relevant regulations, guidelines, and scientific documentation. The Council on Environmental Quality (CEQ) defines significance in terms of context and intensity in 40 CFR 1508.27. This requires that the significance of the action must be analyzed with respect to the setting of the Proposed Action and based relative to the severity of the impact. The CEQ National Environmental Policy Act Regulations (40 CFR 1508.27(b)) provide 10 key factors to consider in determining an impact's intensity.

To provide a conservative evaluation, the impacts screening in this analysis used more restrictive criteria than required under other regulations. Rather than comparing emissions from construction activities with regional inventories, emissions were compared to the individual counties potentially impacted, which is a smaller area.

The Air Conformity Applicability Model (ACAM) version 4.4.5 was utilized to calculate construction, demolition, grading, and paving activities by providing user inputs for each. The ACAM calculations were augmented by emissions calculations of aircraft emissions completed in Microsoft Excel. Aircraft emissions were calculated using proprietary engine data (emissions factors and fuel flow rates) from the aircraft manufacturer, Pratt & Whitney.

Construction Emissions

Calculations for construction emissions were completed using the calculation methodologies described in the U.S. Air Force ACAM. As previously indicated, a conformity determination is not required since Okaloosa County is designated as "attainment."

The ACAM was used to provide a level of consistency with respect to emissions factors and calculations. The ACAM evaluates the individual emissions from different sources associated with the construction phases. Phase I is the site preparation phase and Phase II is the actual building/facility construction phase. These sources include grading activities, asphalt paving, construction worker trips, stationary equipment (such as saws and generators), nonresidential architectural coatings, and mobile equipment emissions (U.S. Air Force, 2003).

Due to limited information, certain assumptions were made to develop the air quality analysis. It was assumed that there would be 23 new facilities/buildings, totaling approximately 94.5 acres would be graded for 3,744,081 square feet of construction, for the Joint Strike Fighter (JSF) Integrated Joint Training Site (IJTS) under the No Action Alternative. Alternative 1A assumed 25 new facilities/buildings totaling 98.3 acres graded for construction of 3,892,375 square feet. It was assumed that 11.62 acres of the land would be paved under both the No Action Alternative and Alternative 1A to complete the JSF IJTS. Alternative 1I assumed 2,225.29 acres would be graded and 3,386,375 square feet of facilities construction would occur. Road improvements and the expansion runway would comprise 39.17 acres paved. Under Alternatives 2A, 2B, and 2C, 3,750 acres would be graded for construction of 6,087,510 square feet of construction, and road improvements, the expansion runway, and the Landing Helicopter Amphibious Deck would make up 100 acres paved. Under Alternatives 2D and 2E, 672 acres would be graded to provide for 3,934,210 square feet of construction and 54 acres would be paved.

The size of each building/facility was entered into the ACAM . Based on these assumptions, the construction emissions were calculated using the methodology expressed below.

Grading Activities

Grading activities are divided into grading equipment emissions and grading operations emissions.

Grading equipment emissions are combustive emissions from equipment engines and are calculated in the following manner:

$$VOC = 0.22\ (lb/acre/day) * acres * DPY_1/2{,}000$$

$$NO_x = 2.07\ (lb/acre/day) * acres * DPY_1/2{,}000$$

$$PM_{10} = 0.17 \text{ (lb/acre/day)} * acres * DPY_1/2{,}000$$

$$CO = 0.55 \text{ (lb/acre/day)} * acres * DPY_1/2{,}000$$

$$SO_2 = 0.21 \text{ (lb/acre/day)} * acres * DPY_1/2{,}000$$

Where

acres = number of gross acres to be graded during Phase I construction

DPY_1 = number of days per year used for grading during Phase I construction

2,000 = conversion factor from pounds to tons

All emissions are represented as tons per year.

Grading operations emissions are fugitive dust and tiny soil particles distributed into the air through ground disturbance and are calculated using a similar equation from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003). This calculation includes grading and truck hauling emissions.

Emissions calculation:

$$PM_{10} \text{ (tons/yr)} = 60.7 \text{ (lb/acre/day)} * acres * DPY_1/2{,}000$$

Where

acres = number of gross acres to be graded during Phase I construction

DPY_1 = number of days per year used for grading during Phase I construction

2,000 = conversion factor from pounds to tons

The calculations assumed that there were no controls used to reduce fugitive emissions. Also, it was assumed that construction activities would occur within calendar year (CY) 2009 through CY 2017 (2,922 days), and that grading activities would represent 10 percent of that total, or 292 days. Construction activities not already approved in the Final Environmental Impact Statement Record of Decision (ROD) were assumed to begin in quarter three of CY 2011 and continue through CY 2017 (2,008 days). The emissions factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003).

Architectural Coatings

Nonresidential architectural coating emissions are released through the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings.

Emissions calculation:

$$VOC_{SF}\ (lb/yr) = (SQR\_GRSQF * 1.63)/2,000$$

Where

SQR_GRSQF = square root of gross square feet of nonresidential building space to be constructed in the given year of construction

1.63 = emissions factor

2,000 = conversion factor from pounds to tons

It was assumed that construction activities would occur within 2,922 days and 2,008 days for ROD-approved and not-yet-approved facilities, respectively. After subtracting the grading activities from the estimated overall construction time, the actual construction period was reduced to 2,630 days and 1,807 days, respectively. Additionally, it was assumed that facilities would be constructed over the eight-year life of the project (CY 2009–2017) at the specified square footage. The emissions factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003).

Asphalt Paving

Volatile organic compound (VOC) emissions are released during asphalt paving operations.

Emissions calculation:

$$VOC_{PT}\ (tons/yr) = (2.62\ lb/acre) * acres\ paved/2,000$$

Where

acres paved = total number of acres to be paved at the site

2,000 = conversion factor from pounds to tons

It was assumed that approximately 11.62 acres would be paved with asphalt under the No Action Alternative and Alternative 1A. For Alternative 1I, 39.17 acres would be paved. One hundred acres would be paved under Alternatives 2A, 2B, and 2C, and 54 acres would be paved under Alternatives 2D and 2E. The specific emissions factors used in the calculations were available through the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003).

Construction Worker Trips

Construction worker trips during the construction phases of the project are calculated and represented as a function of the number of facilities to be constructed and/or square feet of commercial construction.

Calculation:

$$Trips\ (trips/day) = 0.42\ (trip/facility/day) * Area\ of\ training\ facilities$$

Where: Areas of training facilities = total square footage of construction projects to be constructed in the given year of construction

Total daily trips are applied to the following factors depending on the corresponding years.

Year 2009:

$VOC_E = 0.016 * trips$

$NOx_E = 0.015 * trips$

$PM_{10E} = 0.0022 * trips$

$CO_E = 0.262 * trips$

Year 2010 and beyond:

$VOC_E = 0.012 * trips$

$NOx_E = 0.013 * trips$

$PM_{10E} = 0.0022 * trips$

$CO_E = 0.262 * trips$

To convert from pounds per day to tons per year:

$VOC\ (tons/yr) = VOC_E * DPY_{II}/2{,}000$

$NOx\ (tons/yr) = NOx_E * DPY_{II}/2{,}000$

$PM_{10}\ (tons/yr) = PM10_E * DPY_{II}/2{,}000$

$CO\ (tons/yr) = CO_E * DPY_{II}/2{,}000$

2,000 = conversion factor from pounds to tons

DPY_{II} = number of days per year during Phase II construction activities

It was estimated that the total square footage of construction would be 3,744,081 square feet for 23 buildings proposed under the No Action Alternative and 3,892,375 square feet for Alternative 1A. Alternatives 2A, 2B, and 2C would include 6,087,510 square feet, and Alternatives 2D and 2E would include 3,934,210 square feet of construction. The emissions factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003).

Stationary Equipment

Emissions from stationary equipment occur when gasoline-powered equipment (e.g., saws, generators) is used at the construction site.

Emissions calculations:

$$VOC = 0.198 \text{ pounds (lbs)/day} * (GRSQFT) * DPY_{II}/2{,}000$$

$$NO_x = 0.137 \text{ lbs/day} * (GRSQFT) * DPY_{II}/2{,}000$$

$$PM_{10} = 0.004 \text{ lbs/day} * (GRSQFT) * DPY_{II}/2{,}000$$

$$CO = 5.29 \text{ lbs/day} * (GRSQFT) * DPY_{II}/2{,}000$$

$$SO_2 = 0.007 \text{ lbs/day} * (GRSQFT) * DPY_{II}/2{,}000$$

Where

GRSQF = gross square feet of commercial buildings to be constructed during Phase II

DPY_{II} = number of days per year during Phase II construction

2,000 = conversion factor from pounds to tons

It was estimated that the total square footage of construction would be 3,744,081 square feet for 23 buildings proposed under the No Action Alternative and 3,892,375 square feet for Alternative 1A. Alternatives 2A, 2B, and 2C would include 6,087,510 square feet and Alternatives 2D and 2E would include 3,934,210 square feet of construction. The emissions factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003). The emissions factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (U.S. Air Force, 2003).

Mobile Equipment

Mobile equipment (such as forklifts and dump trucks) emissions include pollutant releases generated by the equipment during Phase II construction.

Emissions calculations:

$$VOC = 0.17\ lbs/day * (GRSQFT) * DPY_{II}/2{,}000$$

$$NO_x = 1.86\ lbs/day * (GRSQFT) * DPY_{II}/2{,}000$$

$$PM_{10} = 0.15\ lbs/day * (GRSQFT) * DPY_{II}/2{,}000$$

$$CO = 0.78\ lbs/day * (GRSQFT) * DPY_{II}/2{,}000$$

$$SO_2 = 0.23\ lbs/day * (GRSQFT) * DPY_{II}/2{,}000$$

Where

GRSQF = gross square feet of training area to be constructed during Phase II

DPY_{II} = number of days per year during Phase II construction

2,000 = conversion factor from pounds to tons

The same assumptions for square footage were utilized as described previously.

Vehicle Emissions

Vehicle emissions are generated from on-road base-employee commuters, on-road government use, and off-road base-support vehicles. The total number of personnel expected to be realigned are 2,481 for bedding down three squadrons under all Alternatives.

On-Road Base Employee Commute Emissions

Emissions calculation:

$$E_p = F \times 2 \times (N \times COMDIST \times (1 - ONBASE) \times WORKDAYS \times \frac{EF_p}{454 \times 2000}$$

Where

N = number of personnel realigned

F = fraction of the year the personnel operate

COMDIST = one-way commute distance, miles for off-base personnel

ONBASE = fraction of personnel living on base

WORKDAYS = number of work days per year, assumed to be 230

EF_p = emissions factor for pollutant, *p*, grams/mile. These factors were determined from MOBILE 6 for total hydrocarbons (VOCs), CO, and NO_x for the chosen fleet mix.

2 = number of commutes per work day

454 = conversion factor from grams to pounds

2,000 = conversion factor from pounds to tons

On-Road Government-Owned Vehicle (GOV)

Emissions calculation:

$$E_p = N \times F \times GOVVMT \times \frac{EF_p}{454 \times 2000}$$

Where

N = number of personnel realigned

F = fraction of the year the personnel operate

GOVVMT = per-employee volume of miles traveled (VMT), miles/employee

EF_p = emissions factor for pollutant, *p*, grams/mile. These factors were determined from MOBILE 6 for total hydrocarbons (VOCs), CO, and NO_x for the chosen fleet mix.

454 = conversion factor from grams to pounds

2,000 = conversion factor from pounds to tons

Off-Road Base-Support Vehicles

A variety of off-road base-support vehicles are used at typical Air Force installations. There are many types of these vehicles, both gasoline and diesel fueled. Since specific numbers and types of vehicles for each base are difficult to obtain, emissions from this category are assumed to be proportional to personnel, with an emissions factor derived from aggregate emissions for a typical base.

Emissions calculation:

$$E_p = N \times F \times \frac{EF_p}{2000}$$

Where

N = number of personnel realigned

F = fraction of the year the personnel operate

EF_p = per employee emissions factor, pounds. Total emissions for this category were derived from the 1992 emissions inventory of March Air Force Base and the total number of employees for 1992 at the base. The emissions factors are as follows:

SO_2 = 0.24, PM_{10} = 0.34, CO = 7.91, VOC = 0.74

2,000 = conversion factor from pounds to tons

Aircraft Emissions

Due to limited information, certain assumptions were made to develop the air quality analysis. The baseline aircraft emissions were calculated using the proposed operation tempo outlined in Chapter 2 of the Revised Draft SEIS. The sortie activities would involve F-35, F-16C/D, and F-18 aircraft for the JSF.

JSF Assumptions

Currently, the emissions factors in different engine modes are in development stages for the F-35A (conventional take-off and landing [CTOL]) and F-35C (short take-off vertical landing [STOVL]). Since emissions factors were unavailable for the F-35B (carrier variant [CV]) model, the F-35A emission factors were used to calculate F-35B emissions. The raw data were available and used to obtain the necessary emissions factors to complete this analysis but are not available for inclusion in this document. The calculation process used for the F-16C/D and F-18 illustrates the process used for the F-35 aircraft as discussed in the following section.

Various assumptions were used to obtain the necessary emissions factors for the F-35 analysis. To obtain NO_x, VOC, and CO emissions, the manufacturer (Pratt & Whitney) of the F-35 engine ran various emissions tests at different fuel flow rates. These data were used to create a curve to obtain the appropriate emissions at fuel flow rates anticipated to fly in the various modes (idle, takeoff, etc). There were no data, however, for emissions when the engine was run in afterburner; therefore, known afterburner emissions from the F-119 variant engine (which is used in the FA-22 aircraft) were used. The emissions for the afterburner assume a fuel flow rate greater than 50,000 pounds per hour. For Alternative 1 alternatives, approximately 12 percent of departures are assumed to be afterburner takeoffs. For Alternative 2 alternatives, approximately 56 percent of departures are assumed to be afterburner takeoffs.

Sulfur dioxide emissions factors were calculated with the assumption that all sulfur in the fuel is converted to sulfur dioxide. Using sulfur content numbers from the Air

Force Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations, a sulfur dioxide emissions factor could be calculated (O'Brien and Wade, 2003). This number was used for all fuel flow rates.

The particulate matter emissions factors, which were obtained from the Navy Aircraft Environmental Support Office (AESO), are based on measurements of emissions for a number of aircraft engines.

Aircraft Flying Operations

Aircraft operations of concern are those that occur from ground level up to 3,000 feet above ground level (AGL). The 3,000-foot AGL ceiling was assumed as the atmospheric mixing height above which any pollutant generated would not contribute to increased pollutant concentrations at ground level. The *aircraft operation of interest* within the mixing zone is the landing and takeoff (LTO) cycle. The LTO is characterized by five modes of operation: approach, taxi-in, taxi-out, takeoff, and climb-out.

The LTO cycle is the basis for calculating pollutant emissions. For each mode of operation during an LTO cycle, an aircraft engine operates at a specified power setting and for a specific period (time in mode). The pollutant emission rate is a function of the engine's operating mode, the fuel flow rate, and the engine's overall efficiency. Emissions for one complete LTO cycle for a particular aircraft are calculated by knowing the specific engine pollutant emissions factors for each mode of operation.

The U.S. Air Force has developed emissions factors for aircraft engines, and Table D-2 presents an example of the emissions factors and aircraft engine performance data for each of the aircraft type used in this analysis. The table lists the various engine modes, time in for each mode, fuel flow, and corresponding pollutant emissions factors. Using these data, as well as information on activity levels (i.e., number of sorties/LTO operations), pollutant emissions for each aircraft were calculated

Table D-2. Aircraft Performance Data and Emissions Factors

Aircraft Type	Power Setting	Fuel Flow Rate (lb/hr)	Emissions Factors (lb pollutant/1,000 lb fuel)			
			NO_x	CO	VOC	PM_{10}
F-16C/D	Idle	1,036	3.19	34.58	2.64	2.61
	Approach	4,956	11.6	3.85	0.05	1.37
	Intermediate	7,136	17.33	2.49	0.01	0.57
	Military	9,985	27.13	2.42	0.54	0.14
	AB-1	16,826	15.08	104.60	64.80	3.34
F-18	Idle	654	1.43	123.75	54.82	4.48
	Approach	3,110	7.14	3.17	0.85	1.46
	Intermediate	6,503	15.92	1.32	0.27	1.57
	Military	7,617	22.27	1.33	0.24	1.61

Source: O'Brien and Wade, 2003
CO = carbon monoxide; hr = hour; lb = pound; NO_x = nitrous oxides; PM_{10} = particulate matter with an aerodynamic diameter of 10 microns or less; VOC = volatile organic compound

Aircraft flying operations were calculated in ACAM using LTO cycles. As previously described, emissions from engine exhaust occur for each operation during idle/taxi-out, takeoff, climb-out, approach, and taxi/idle-in (Table D-4). Only those portions of the flying operation that take place below the atmospheric mixing height are considered (these are the only emissions presumed to affect ground-level concentrations).

Table D-3. Aircraft and Engine Mode

Aircraft Mode	Engine Mode
Taxi/Idle-out	Idle
Takeoff	Military or Afterburner
Climb-out	Intermediate
Approach	Approach
Taxi/Idle-in	Idle

Emissions calculation based on aircraft flying operations:

$$Ep = N * F * OPS * NUMEG * (\Sigma TIMi * EFi,p)/2{,}000)$$

Where

N = number of aircraft

F = fraction of the year the aircraft operate

OPS = the number of operations [total LTOs and touch and go (TGOs)] per year for each aircraft in the Proposed Action unit

TIMi = time in mode for aircraft operating mode, *i*, hours

The engine operating mode used in the emissions factors is correlated to the aircraft operating mode as follows.

M = number of aircraft operating modes (five for LTOs; three for TGOs)

NUMEG = the number of engines for the aircraft type

EFi,p = emissions factor for pollutant, *p*, for each engine operating mode, *i*, lb/hr

2,000 = conversion from pounds to tons

JSF airfield operations were based on the flight training syllabus and operations tables provided by the Air Force. Airfield operations numbers used in the analysis are given for in Chapter 2 of the SEIS. Air emissions were estimated for each criteria pollutant based on fuel flow rates for each engine mode (e.g., idle, taxi, intermediate, military) per the Karnes 2 flight profiles.

Emissions were also calculated for aircraft flying below 3,000 feet AGL while completing training operations. These occurred in airspace units in Georgia, Alabama, Mississippi, and Florida. Using operation tables provided by Eglin Air Force Base (AFB), the amount of time an aircraft is under 3,000 feet AGL in the various airspaces was determined for each of the aircraft types. A weighted engine thrust ratio (ETR) of 59 percent was assumed for in-flight operations (Long, 2012). To determine an appropriate estimate of fuel flow rate (FFR) and the emission indices (in pounds per 1,000 pounds of fuel) for each of the criteria pollutants, a variety of ETRs were used from the F-35C P-22 pattern profile to create regression lines for each of the pollutants and FFR. By inputting the weighted ETR in each regression line equation, an emissions index was determined for each pollutant. Emissions were then calculated for each airspace in the following manner:

$$Ep = (T_{airspace} * (FFR/1000) * EI_p)/2000$$

Where

E_p = Emissions of pollutant, p, in tons per year

$T_{airspace}$ = Time all aircraft in airspace below 3,000 feet AGL (hours per year)

FFR = Fuel flow rate (pounds per hour)

1000 = Factor for converting pound per hour to 1,000 pounds per hour

EI_p = Emission Index for pollutant, p (pounds per 1,000 pounds of fuel)

2000 = Factor to convert pounds to tons

Airspace units cover large areas of ground and often cover multiple counties. Due to the large area and uncertainty of knowing the precise area within any airspace an aircraft may be operating, the emissions were compared to an ROI consisting of all counties that underlay the airspace.

Aircraft Ground Operations (Trim Tests)

Trim tests are engine tests performed with the engines on the aircraft. All engines on the aircraft are assumed to be tested the same number of times each year.

Emissions calculation:

$$Ep = N * F * TRIMS * NUMEG * (\sum TIMi * EFi,p)/2,000)$$

Where

N = number of aircraft

F = fraction of the year the aircraft operate

TRIMS = the number of engine trim tests per year for each engine

TIMi = time in mode for operating mode, *i*, hours (this refers to the engine operating mode)

M = number of engine operating modes

NUMEG = the number of engines for the aircraft type

EFi,p = emissions factor for pollutant, *p*, for operating mode, *i*, lb/hr (particulate matter is conservatively assumed to be 100 percent PM_{10})

2,000 = conversion from pounds to tons

Auxiliary Ground Equipment (AGE) and Auxiliary Power Units (APUs)

Auxiliary ground equipment (AGE) includes such aircraft support equipment as air compressors, air conditioners, aircraft tug narrows, cargo loaders, baggage tugs, deicers, fuel trucks, generators, ground heaters, hydraulic test stands, jacking manifolds, and miscellaneous other equipment. Auxiliary power units (APUs) include onboard equipment that provides power to the aircraft while it is on the ground and sometimes through takeoff and climb-out.

Emissions were calculated using the number of LTO cycles for one aircraft type chosen for each Alternative, and for this SEIS, the training activities were chosen as the proposed action for ACAM. Annual emissions were obtained for each aircraft chosen and the associated AGE and APU equipment for that aircraft using the following process. The number of LTO cycles for one aircraft per aircraft type chosen is multiplied by the total number of aircraft per aircraft type, the AGE/APU equipment operating time (hours) per LTO cycle, the published emissions factor, and the load factor as well as the rated horsepower.

AGE and APU emissions calculations:

Ep (tons per year) = N * OT * LTO * LF/100 * EF * (1/2,000)

N = total number of aircraft per air craft type

LTO = number of LTO cycles per aircraft per year

OT = AGE and APU equipment usage rate in annual average hours

ACAM default values were used for AGE and APU calculations.

Munition Emissions

Munition emissions for JSF flight training operations were calculated using the same methodology. For all live munitions, net explosive weights and emissions factors were used to complete the analysis (Table D-4).

Emissions calculation:

$$Pollutant\ Emissions = EF*NEW*Qty/2{,}000$$

Where

pollutant emissions = emissions for the associated pollutant (i.e., CO or NO_x) (tons/yr)

EF = emissions factor for the pollutant (lb/lb NEW)

NEW = net explosive weight (lb NEW/item)

Qty = quantity (item/year)

2,000 = conversion from pounds to tons (1 ton = 2,000 pounds)

Table D-4. Munitions for JSF Operations Emissions Factors

Munition Type	NAA Quantity	59 Aircraft Quantity	NEW (lb/item)	Emissions (lb/lb NEW)				
				CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x
JSF								
GBU-12 live	350	36	192.0	0.44	1.05	0.00	0.00	0.01
GBU-12 inert	121	235	0.00	0.00	0.00	0.00	0.00	0.00
GBU-31 live	0	0	495.0	0.44	1.05	0.00	0.00	0.01
GBU-31 inert	0	61	0.00	0.00	0.00	0.00	0.00	0.00
GBU-38 inert	0	79	0.00	0.00	0.00	0.00	0.00	0.00
25mm (TP)	114,977	114,977	0.12	0.0070	0.0016	0.0066	0.0130	0.0000
Flares (MJU-8/27)	752	752	0.63	0.01	0.00	0.00	0.07	0.00

Source: USEPA, 2009a

CO = carbon monoxide; GBU = guided bomb unit; lb = pounds; mm = millimeter; MJU = munitions countermeasures unit; NAA = No Action Alternative; NEW = net explosive weight; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter with an aerodynamic diameter of 2.5 microns or less; PM_{10} = particulate matter with an aerodynamic diameter of 10 microns or less; SO_x = sulfur oxides; TP = target practice

NATIONAL EMISSIONS INVENTORY

The NEI is operated under the USEPA's Emissions Factor and Inventory Group, which prepares the national database of air emissions information with input from numerous state and local air agencies, tribes, and industries. The database contains information on stationary and mobile sources that emit criteria air pollutants and hazardous air pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on a yearly basis. The NEI includes emissions estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emissions estimates for individual point or major sources (facilities), as well as county-level estimates for area, mobile, and other sources, are currently from an extract of USEPA's NEI database. Data were extracted in August 2005 (1999 emissions) and August 2008 (2002 emissions).

Criteria air pollutants are those for which the USEPA has set health-based standards. Four of the six criteria pollutants are included in the NEI database:

- Carbon monoxide (CO)
- Nitrogen oxides (NO_x)
- Sulfur dioxide (SO_2)
- Particulate matter (PM_{10} and $PM_{2.5}$)

The NEI also includes emissions of VOCs, which are ozone precursors, emitted from motor vehicle fuel distribution and chemical manufacturing, as well as other solvent uses. VOCs react with nitrogen oxides in the atmosphere to form ozone. The NEI database defines three classes of criteria air pollutant sources:

- *Point sources.* Stationary sources of emissions, such as an electric power plant, that can be identified by name and location. A "major" source emits a threshold amount (or more) of at least one criteria pollutant and must be inventoried and reported. Many states also inventory and report stationary sources that emit amounts below the thresholds for each pollutant.
- Area sources. small point sources such as a home or office building or a diffuse stationary source such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. Dry cleaners are one example; for instance, a single dry cleaner within an inventory area typically will not qualify as a point source, but collectively the emissions from all of the dry cleaning facilities in the inventory area may be significant and therefore must be included in the inventory.
- Mobile sources. any kind of vehicle or equipment with a gasoline or diesel engine (such as an airplane or ship).

The following are the main sources of criteria pollutant emissions data for the NEI:

- For electric generating units, USEPA's Emissions Tracking System/Continuous Emissions Monitoring Data and Department of Energy fuel use data.
- For other large stationary sources, state data and older inventories where state data were not submitted.
- For on-road mobile sources, the Federal Highway Administration's estimate of vehicle miles traveled and emissions factors from USEPA's MOBILE Model.
- For non-road mobile sources, USEPA's NONROAD Model.
- For stationary area sources, state data, USEPA-developed estimates for some sources, and older inventories where state or USEPA data were not submitted.

- State and local environmental agencies supply most of the point source data. USEPA's Clean Air Market program supplies emissions data for electric power plants.

Greenhouse Gases

Greenhouse gases (GHGs) are chemical compounds in the Earth's atmosphere that trap heat. Gases exhibiting greenhouse properties come from both natural and human sources. Water vapor, carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) are examples of GHGs that have both natural and manmade sources, while other gases such as those used for aerosols are exclusively manmade. In the United States, GHG emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs.

Typically, GHG emissions are represented as CO_2 equivalents (CO_2-e) based on the molecule's global warming potential or ability to trap heat in the atmosphere relative to CO_2 (USEPA, 2005). Therefore, all GHG emissions calculations and analysis in this document are represented in CO_2-e.

The USEPA has recently promulgated several final regulations involving, GHGs either under the authority of the CAA, or as directed by Congress, but none of them apply directly to the proposed action. However, Eglin may be required to adjust their Title V Air Operating Permit under the "Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule," 75 Federal Register 31514, June 3, 2010. Likewise, Eglin has already prepared a Greenhouse Gas Baseline Emissions Inventory (U.S. Air Force, 2010a) and will be required to report annual emissions to USEPA under the "Mandatory Reporting of Greenhouse Gases," 74 Federal Register 56260, October 30, 2009. As an affected facility, Eglin has prepared a Greenhouse Gas Monitoring Plan (U.S. Air Force, 2010b).

The potential effects of GHG emissions from the Proposed Action are by nature global. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, the GHG emissions from the No Action Alternative and the Proposed Action Alternatives have been quantified to the extent feasible in this SEIS for information and comparative purposes.

GHG Construction Emissions

Combustion of fossil fuels by construction equipment and constructions workers' vehicles during commutes to and from the site would contribute to increased GHG emissions. Construction equipment emits approximately 22.2 pounds of CO_2 per gallon of diesel and worker vehicles emit 19.4 pounds of CO_2 per gallon of gasoline (USEPA, 2009b). These emission rates can be decreased with less idling and improved maintenance of equipment. It was assumed that construction vehicles would operate for approximately 1,248 hours annually. Of 250 potential working days, 62.5 percent (or 157 days) are suitable for construction activities (i.e., no precipitation) (Sperling's Best Places, 2010). These vehicles were assumed to each combust 4 gallons of diesel per hour (Fusetti and Monahan, 2008).

Stationary sources for construction were also included in the analysis. It was assumed that a number of small diesel-fueled generators would be operated during working hours. Each generator was assumed to combust one gallon per hour of operation.

It was assumed that construction workers would be required to commute each day for 157 work days. ACAM estimates the average commute to be 15 miles one-way, and 23.9 miles per gallon average was assumed for commuter vehicles (USEPA, 2009b).

GHG Personnel Emissions

The addition of personnel to the region would also lead to increased GHG emissions. The two primary sources for these GHG emissions would be mobile emissions from added personnel commutes, and emissions in the home from personnel running home heating and cooling and other electrical devices. Commuter emissions were calculated using the same methodology as for the construction workers above. The USEPA estimates that in the United States, approximately 4 metric tons of CO_2-e are produced per person per year in the home (USEPA, 2010).

GHG Operational Emissions

Combustion of fuels during flight operations would also cause GHG emissions. Emissions were calculated using fuel flow rates for the respective aircraft. The emissions factor for jet fuel (JP-8) is 22.1 pounds CO_2-e per gallon of fuel, respectively (U.S. Air Force, 2009). Calculations were based on the estimated annual sorties for each aircraft under each alternative as discussed in Chapter 2 of the SEIS.

GHG emissions from munitions use were calculated using emissions factors on a per item basis as outlined in AP-42 (USEPA, 2009a). Munitions to be used under each alternative as well as numbers for each munition type are listed in Chapter 2 of the SEIS.

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